

Portuguese Vaulting Systems at the Dawn of the Early Modern Period. Between Tradition and Innovation

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ABSTRACT: The Portuguese hall churches of the so-called Manueline Period (end of the fifteenth and beginning of the sixteenth century) are generally seen as straddling two contradictory stylistic phenomena. While their formal repertory announces the Renaissance, their conception and execution follow the geometrical and technical principles used by the gothic builders. Nave and aisles are unified spatially, a common goal in all Europe at the time. In the transversal section unification of the vaults is achieved through a continuous curved profile from side wall to side wall. In Portuguese historiography this is seen as characteristic of João de Castilho with the so-called 'barrel vault' of the Hieronymite church at Belém as his masterpiece. The attribution is a polemic issue, but nonetheless relevant. Our investigation has indeed revealed additional examples that certainly deserve a global presentation considering the pertinence of the author issue and of its broader European context.

INTRODUCTION

Mario Tavares Chicó was the first to stress the spatial qualities of Manueline church architecture in 1954. The author appreciated the spatial unity of the Hieronymite church at Belém (Jerónimos) and of the churches at Freixo de Espada à Cinta and Arronches, comparing them favourably with other hall churches in Europe. Thirty years later Mendes Atanázio pointed out an "architectonic consciousness that experiments with new ways of achieving spatial unity". The novelty in Freixo is the "arc of the rib which springs from the bearing wall, crosses every span's vault in its middle, thus allowing a clear perception of a single vault over nave and aisles at quite an even height" (Atanázio 1984, p. 112). This vault can be perceived as a single huge barrel vault arcing over the church space in one continuous curve from one side wall to the other.

During our investigation of João de Castilho's work we have identified other Portuguese hall churches with a comparable barrel-shaped vault: the church of the convent of Jesus (Setúbal), the cathedral of Viseu, and the church of Torre de Moncorvo which is closest to the Jerónimos church.

João de Castilho (died 1552), a key figure in early sixteenth-century Portuguese architecture, who originally came from the neighbourhood of Santander, is allegedly the author of those vaults, but there is not much documentary evidence available, as we shall see. A relevant fact is that Castilho actually married and lived in Freixo de Espada à Cinta. In Jerónimos also, his interventions in the sacristy, cloister, and transept are fully documented. Analysing the architecture of the Jerónimos vaults is thus crucial to the authorship issue; our analysis has indeed enabled us to attribute the nave to him, too (Monteiro 1995). In other cases such as the Setúbal formal similarities with documented works such as the cathedral of Braga justify the attribution, and a similar relationship can be established between Freixo de Espada à Cinta and Arronches on the one hand and Jerónimos on the other. In any of these churches, the presence of João de Castilho can thus be proven or at least surmised with some degree of probability.

Formal comparisons have led to the widespread use of the term "Basque vault" in Portuguese literature, named after the "Basque" origin of João and his equally talented brother Diogo de Castilho. The term designates the stellar vaults with curved liernes which are seen as "typical" of the brothers and their milieu. Unfortunately, its hackneyed use has often precluded a more thorough investigation of these vaults.

In this paper we will present the result of our surveys and observations on site, while focussing on the spatial characteristics of the hall churches and on the geometry and structure of their vaults. It is our contention that in the analysis of these formal, geometrical and structural qualities the answer to the question of their creator may be found. We also believe that the order, in which we present these cases, corresponds with a logical line of development culminating in the great achievement of Jerónimos.

THE HALL CHURCHES

Convent of Jesus Church – Setúbal

The Convent of Jesus church consists of a main chapel, nave and choir (at the western end). The main chapel is a little higher than the nave, with a star-shaped vault showing curved liernes in its crown. The nave (19,40m X 10,24m) is divided into four bays. The central nave is covered by a domed rib vault ($h= 13,15m$). The side aisle is covered by a half barrel vault ($h= 10,85m$). The ribs present a large, flat profile, mostly the transversal and longitudinal ones, accentuating the division of the bays. Construction started under the reign of King John II (1455-1495); the church was enlarged under King Manuel I with replacement of the original timber covering by a vault.

Boitaca is considered by contemporary chronicles to be the author of the convent. Polemics about that attribution exist, mostly with regard to the vault of the main chapel. Some of its features are seen as "typically Basque"; the resemblance with the vault of the chevet of Braga cathedral, a documented work, in particular has driven some authors to defend it as an achievement of João de Castilho. In that case the main chapel at Setúbal would have to be of a later date than the rest (Pedro Dias, 1978, pp. 71-72). However, recent archaeological excavations have confirmed that the masonry of the main chapel and nave is contemporary, including its buttresses, excepting only the portal and buttress of the elevated west choir (Silva et al. 1989, p. 23). Nevertheless, it was fairly common practice to build the vault only after a certain time had elapsed after construction of the walls.

The debate on the main chapel has relegated the nave to a secondary position. However, it deserves all of our attention for the most unusual shape given to the vault in its side aisles (Fig. 1). Could this be a first attempt to unify all aisles under a single 'barrel' vault? Chicó recognizes this as a mark of the mendicant orders: "Our churches of the mendicant orders and others influenced by them, with the small difference in height between their naves and aisles, might have driven the gothic builders to adopt the Hallenkirchen style [...] more quickly than in other European countries" (Chicó 2005, p. 155).

The architect attempted to unify all spaces in a thoroughly original manner, transversally as well as longitudinally, but his idea did not come off perfectly in practice. By having the half barrel soffit meet the apex of the arch between nave and side aisle, there is a suggestion of continuity between the surfaces of the lateral and central vaults. Unfortunately, the rib vaults in the nave have a nearly horizontal crown and thus the transversal cells do not curve down enough at the sides to achieve a really fluid transition; the intervening vertical wall surface seems disruptive. (This wall of course supported the original timber ceiling; i.e. the architect had to cope with a pre-existing condition.) We recognize a similar attempt at smoothing over the transition between nave and apse through a half vault which has the effect of pulling the apse vault visually closer to the viewer standing on the main axis of the nave.

Through observation, we could analyze the relationship between the horizontal and vertical sections and confirm the use of the domed groin vault principle: the height of the vault is equal to the half diagonal on the plan. The height is measured from the springing of the arches and ribs, which is lower in the side aisles.

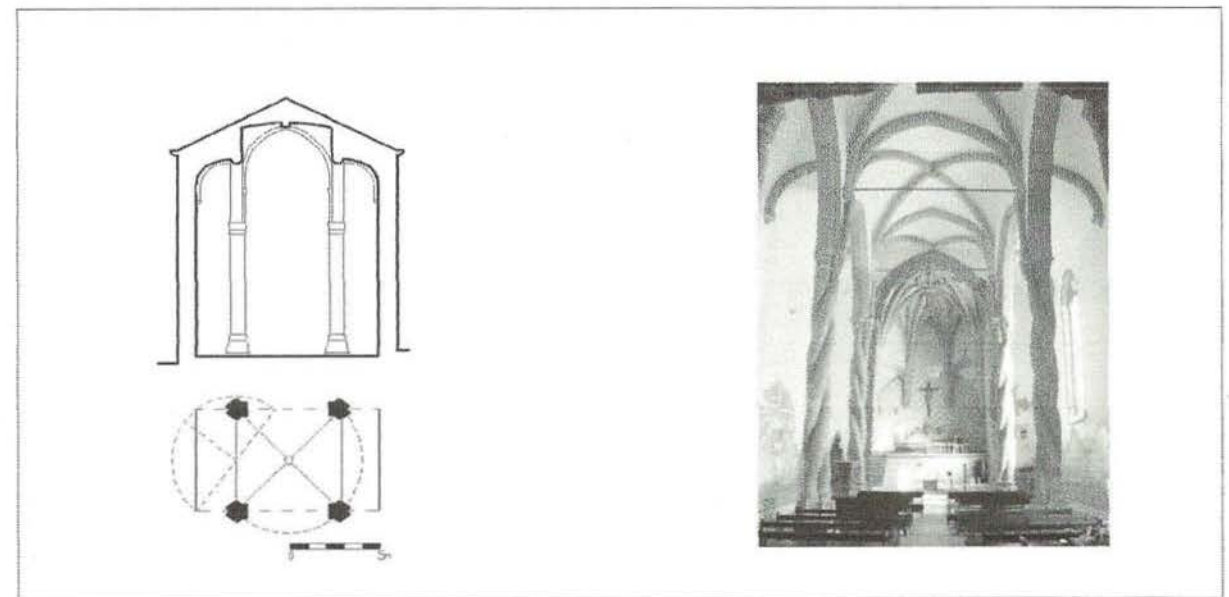


Figure 1: Cross section and plan of nave and aisles – Monastery of Jesus Church – Setúbal

Viseu Cathedral

During the Manueline period, Viseu Cathedral went through major changes that include the façade and the vaults of the church. The works were ordered by Spanish Bishop Calçadilha de Vilhegas and were completed in 1513, as indicated by an inscription on the façade which eventually collapsed in 1635.

The direction of the works is usually attributed to João de Castilho based on the lowered shape of the vault of the choir, seen as characteristic of his architecture, hence on the traditional reference to a "Basque master" in the historiography. There are also voices to the contrary which stress the lack of credible documentation and also the activity of Castilho on other sites at that time, namely Braga and Vila do Conde.

The church consists of a nave and a transept (33,25m x 7,10m). The vault of the nave and west choir (24m X 17m) is divided into only three bays on a nearly square plan, while the side aisles show rectangular bays. The rib vaults of the nave reach 14,40m at the keystone; the domed rib vaults in the side aisles come close to this with 12,15m at the keystone. The transept is covered by vaults identical to the naves, in plan and in height, with one supplementary vault on each side reaching 12,00m in height.

In spite of the differences in height between nave and aisles, the transversal section shows an almost continuous curve between the boundary walls (Fig. 2). This was achieved by raising the arches between side aisle and nave to the proper intermediary level, so that adjacent cells in both vaults seem part of one curved surface. Continuity between nave and aisles and between bays on the longitudinal axis is stressed by the knot-shaped ridge ribs along the transversal and longitudinal axis of the vaults. Unfortunately, the transversal unity is somehow weakened by the presence of six massive columns – diameter 1,80m – supporting the vaults and probably dating from a previous phase. All ribs show similar profiles but, as in Setúbal, the longitudinal and transversal arches are more massive, which emphasizes the separation between bays (see Fig. 10).

Similar to a domed groin vault, each rib vault obeys the following geometrical principle: the height of the vault corresponds to the half diagonal on the plan. As in Setúbal, the springing of the side vaults is lower than in the main nave, as shown by the height difference of the capitals on the central columns.

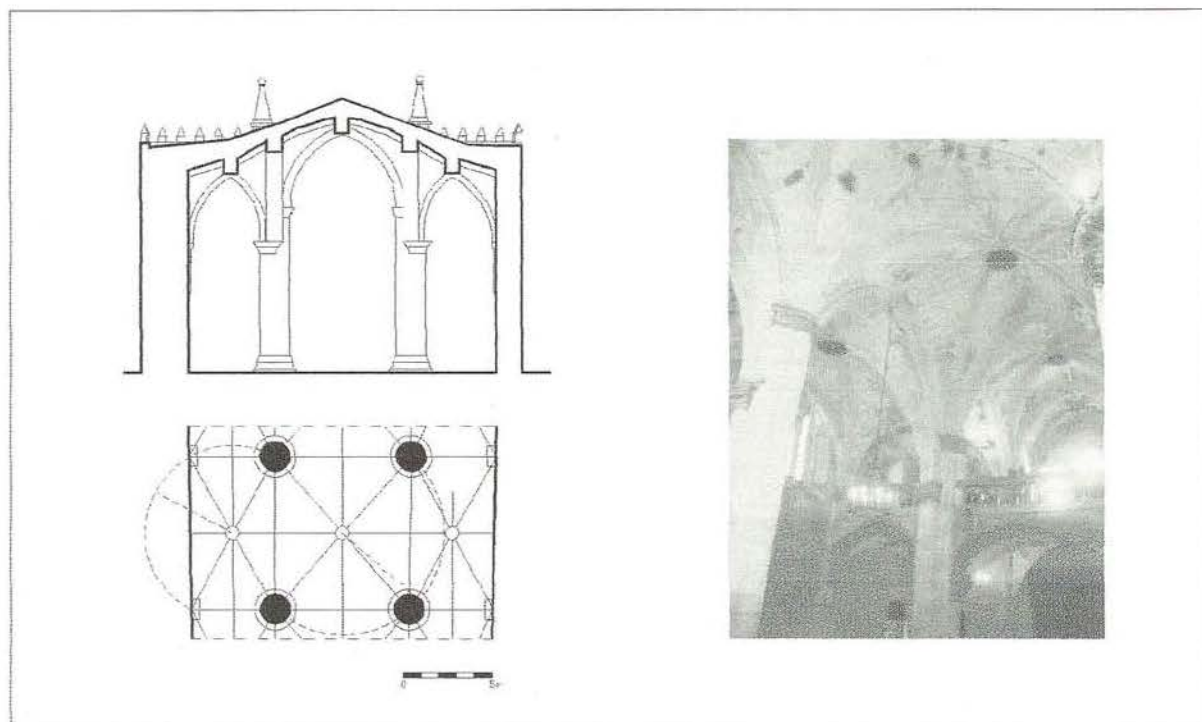


Figure 2: Cross section and plan of nave and aisles – Viseu Cathedral

Church of Freixo de Espada à Cinta

The construction of the church at Freixo de Espada à Cinta began before the Manueline period. Only during King Manuel's reign, however, a more extensive building campaign was launched. After the king's death (1521), the church remained incomplete for quite a long period. The choir and pulpit were only completed under King John IV (1604-1656). The north and south lateral chapels seem to be posterior, since no continuity can be found within their walls with the main chapel, among others (Pintado 1991, pp. 49-51).

The attribution of this church to João de Castilho usually relies not only on the similarities with the nave of Jerónimos but also on the fact that he actually got married and lived in Freixo (Moreira 1991, p. 438).

The church consists of a nave, (west) choir, main and side chapels, and sacristy. The square main chapel is covered by a star-shaped so-called 'Basque' vault with liernes forming a flower pattern. As in the nave of Viseu cathedral, the vaults of the side chapels are domed; i.e. the profile on the diagonal forms a perfect semi-circle as in a domed groin vault, with curved liernes on the crown. The vault of the nave and west choir (31,10 m x 15,90 m) is divided into five bays by svelte columns ($D=0.76\text{m}$). Longitudinal, transversal and diagonal ribs of (almost) equal profile – the diagonals are slightly thinner (see Fig. 10) – spring from these and spread in all adjoining quadrants, thus visually tying together the soffits of main and side vaults (Fig. 3). Moreover, as in Viseu a continuous transversal arc is achieved from wall to wall by leveling the longitudinal rib between the columns to precisely the desired height. In this case the continuity is much better expressed, since the height difference between the main nave (11,80m) and side aisles (11,20m) is much less, and through the specific configuration and profile that was given to the ribs. A ridge rib follows the axis of each bay, stressing the continuity of the curve. This 'barrel' profile must have been designed by first fixing the height of the three keystones relative to the level of the springing of the ribs; with these three points the circle segment was geometrically determined. This relative height in fact corresponds to half the diagonal of each bay. This geometric configuration was also systematically applied to the following three examples.

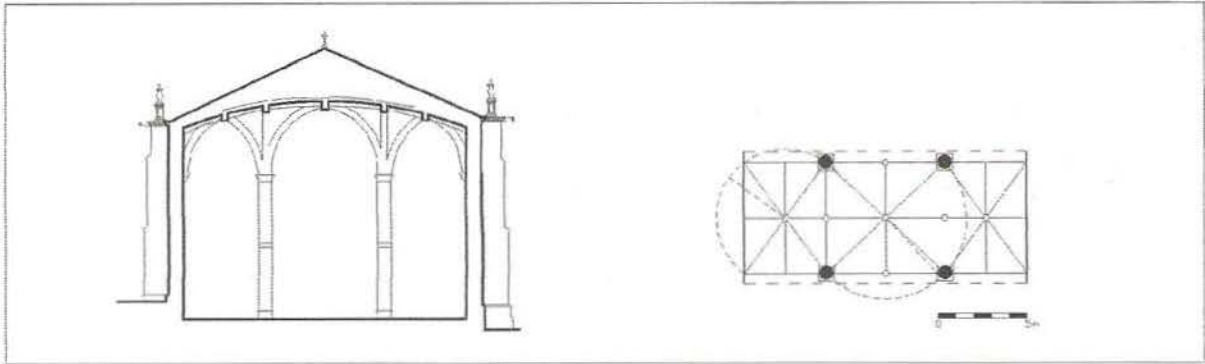


Figure 3: Cross section and plan of nave and aisles – Church in Freixo de Espada à Cinta

Arronches Church

The church of Arronches dates from the beginning of the sixteenth century. The existing bibliography is extremely vague and scarce concerning the author of its plan. However, due to the architectonic similarities to the nave at Jerónimos, the author might be the same, i.e. João de Castilho. The church is composed of a nave and aisles, west choir, main and side chapels, sacristy and lateral annexe. The main body (30,70 m x 15,30m) is divided into five bays by thin columns. In this particular church, one can no longer speak of square or rectangular bays for nave and aisles since there are no longitudinal arches separating the latter: in each transversal bay, nave and aisles thus merge smoothly (Fig. 4). Each of these units consequently received a single vault defined by transversal and diagonal ribs only, which emphasize very clearly its transversal dimension. A diagonal reading of the vault is also assured. The transversal ridge does not run all the way to the boundary wall as usual, but ends at the keystone above the side aisle. The transversal and diagonal reading of the vault is made even easier since the diameter of the six columns is only 0,73m. The respective sizes of the transversal and diagonal ribs are comparable, although they present different profiles (see Fig. 10). The Arronches 'barrel' vault presents a very flat general profile, due to extremely reduced difference of height between the main nave (11,60m) and the aisles (11,40m).

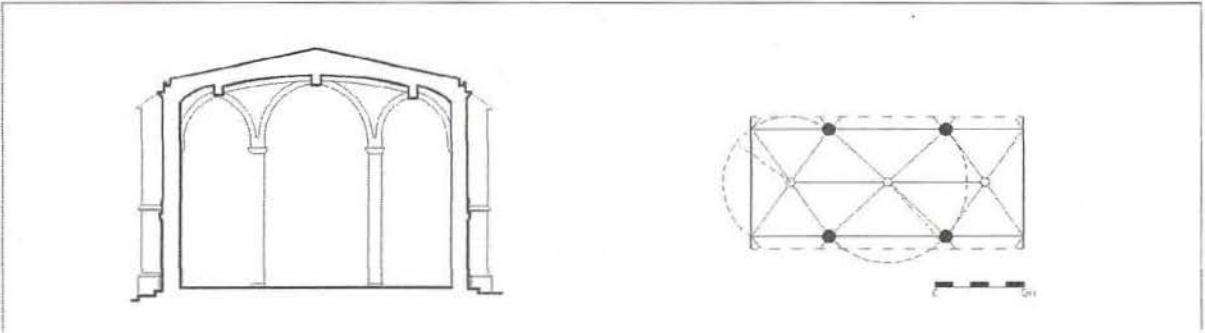


Figure 4: Cross section and plan of nave and aisles – Church of Arronches

Moncorvo Church

The bibliography about Moncorvo is extremely sparse. This building seems to have gone unnoticed by the historians of art who usually deal with Manueline style. The beginning of the construction is situated by most of the sources between 1450 and 1556. However, according to the geographer João de Barros the vault was already completed around 1549, and he indicates that the construction was probably initiated in the beginning of the sixteenth century. Moncorvo would thus have been a long drawn-out undertaking, spanning the entire period from King Manuel I to the Philippine monarchs. In fact the construction was completed only between 1609 and 1638 (Cavalheiro et al., 1998, pp. 29-30). An intervention of João de Castilho cannot *a priori* be excluded, since Moncorvo is not very distant from Freixo. Even better than the previous case, this church presents a unique covering crossing nave and aisles on a rectangular plan (37,30m x 19,38m), also divided into five bays. The vault is supported by eight columns (diameter 1,10m) and by walls reinforced by half columns on the inside and buttresses on the outside. It consists of granite ribs with a thin profile and of cells in brick masonry. The transversal curved shape is relatively flatter than in the previous example, due to the small difference in height between the nave (15,75m) and aisles (15,25m). Transversal arches have been used, but in the side aisles the diagonals have been replaced by two pairs of tiercerons meeting at the end of the ridge rib which follows the length of the vault (Fig. 10). The ridge ribs of the centre vault extend sideways through the ridge ribs of the side aisles and lengthwise to the next bay. In the centre vault, liernes running between the diagonal ribs and ridge ribs emphasize the equal status of both axes, lengthwise and across the body of the church. The curved shape of the vault is thus also emphasized. Unlike at Viseu, Freixo de Espada-à-Cinta and Arronches, the diagonal rib in this vault changes its curvature at the meeting point with the square formed by the liernes. Nevertheless, as at Freixo and Arronches, the height of the vault corresponds to the half diagonal on the plan, the three keystones determine a single curve, the "barrel" profile which spans nave and aisles.

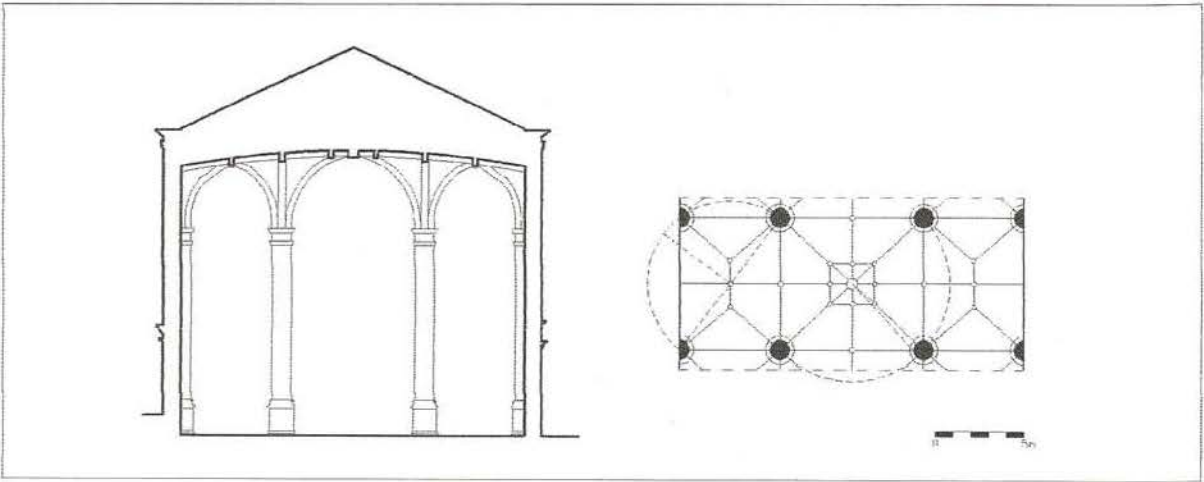


Figure 5: Cross section and plan of nave and aisles – Church of Torre de Moncorvo

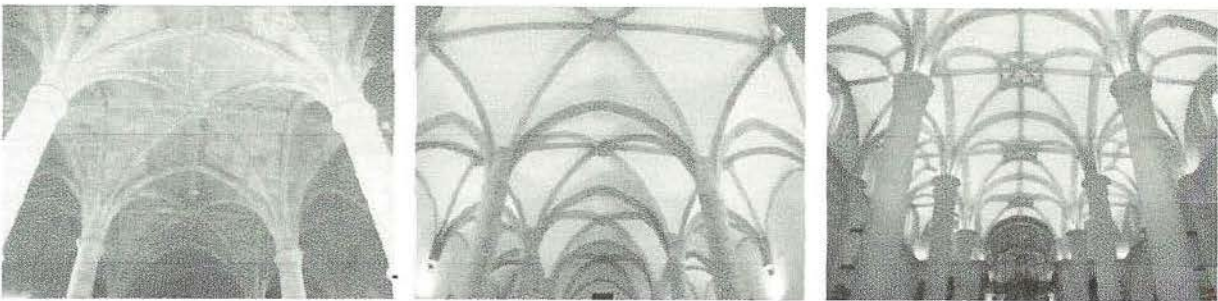


Figure 6: From left to right, vaults at Freixo de Espada à Cinta, Arronches and Torre de Moncorvo

Jerónimos Church

The Hieronymite church at Belém (Jerónimos) is built on a Latin cross plan and consists of a nave and aisles with transept, two lateral chapels, main eastern choir chapel and elevated western choir 'tribune'. The main body of the nave and west choir (50,80m x 22,40m) is divided into five by two rows of octagonal pillars (diameter 1,00m - height 17,00m). The pillars of the transept are more massive, composed of 4 blocks juxtaposed, with identical section of the pillars of the nave, signing up in a circle of about 2.00 m in diameter. The general profile of the vault is quite flat, since the difference of height is small: 24,00m in the nave and 23,20m in the side aisles. These are not formally divided from each other at vault level, since the conventional longitudinal, transversal and even diagonal arches have been replaced by a net of opposed triangles formed by liernes and tiercerons. The liernes – straight or curved – have been disposed in order to amplify the curved soffit of the vault, in length as well as in width, using octagons, squares and rhombs.

The transept vault is unique in its dimensions: it spans 28,50m x 19,00m without any intermediary support between the walls. It is composed of ribs with distinct profiles: two major transversal arches in its width, supported by pillars and consoles, tiercerons which trace circles on the summit of the vault, followed by thinner liernes (see Fig. 10).

For a more detailed description, we refer to our earlier studies which document its geometry and form (Genin 2001), and its composition (Genin 2003). Let us stress, however, that in this case also the height of the keystone of the diagonal – which is not rendered visible by a rib – is "defined" by a semicircle as in the precedent examples.

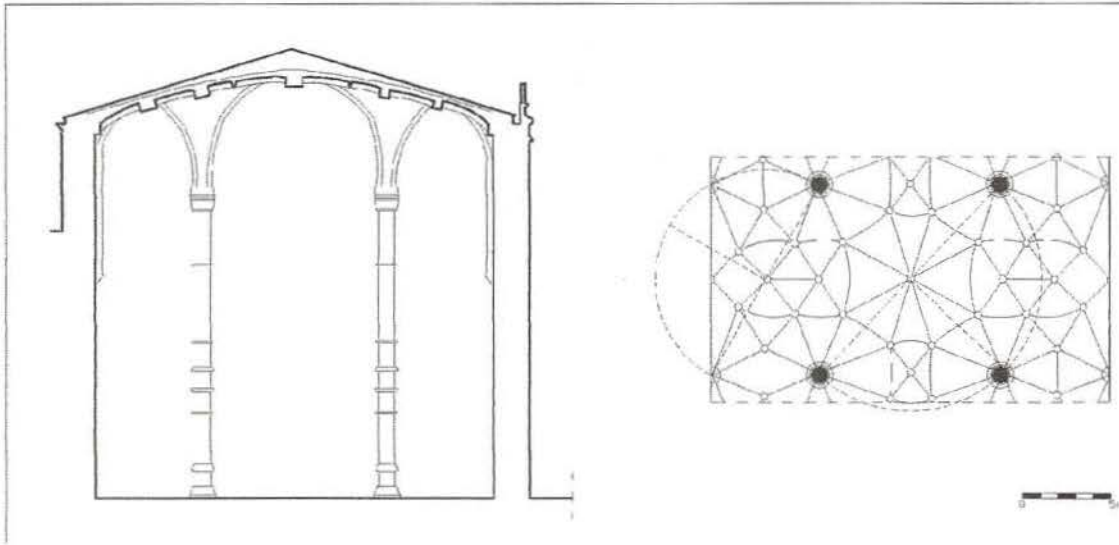


Figure 7: Cross section and plan of nave and aisles – Church of Jerónimos

It is our aim to complete the information regarding its author.

When construction began (probably in 1504) the church of Santa Maria de Belém (better known as Jerónimos) was the biggest undertaking at the time in Portugal, and one which attracted many foreigners to work. The two best known names are Boitaca, between 1514 and 1516, as author of the initial plan, and João de Castilho, who is connected with the main construction phase between 1516 and 1523. There is some confusion concerning their respective responsibilities, in particular as regards the nave vault. As we analyse its architecture, few doubts remain on this point: it is the work of a single author. What do the accounts – our main source of information – teach us in this respect (Correia 1922)?

Boitaca was responsible, among others, for the cornices of the church, for which he received payment. This means that the walls were already completed when João de Castilho arrived; the latter is mentioned for the first time in 1516, when Boitaca was still in charge. Castilho subsequently replaced Boitaca as shown on the payroll. He directed the work on the cloister, chapter house, sacristy and south portal, backed by 110 workers amongst whom Pedro Goterres (in the chapter house), Rodrigo de Pontezilhas (chapter house door), Fernando de la Ferosa (sacristy), Francisco de Benavente and Pero de Trilho (in the cloister) and Nicolas de Chanterène from France (main gate). In 1518 Castilho was working with 146 men, Leonardo Vaz supervising the refectory team and João Gonçalves and Rodrigo Afonso working in the three chapels of the choir.

The 1519 accounts show some information about the church: Benavente was cutting the pillars with 30 other men, most of them French and Spanish, Pontezilhas did stonework in the church with 46 foreigners.

The ground floor of the cloister was completed and only two bays remained to be done on the first floor. Virgilio Correia has suggested that maybe the works were delayed for economic reasons, since only Pontezilhas and other artists were still working, while some others left to work in the cathedral of Seville. At the end of 1518,

João de Castilho is no longer listed in the ledger. Yet we know that in 1521, the king allocated him some neighbouring houses, which suggests that his presence on the site was still necessary (Moreira 1991, p. 145). In 1522, King John III assigned him work on the pillars and vault of the transept. While the author of the transept is known, the nave is not documented in that regard, although, due to the similarities between the two vaults and their close relationship, few doubts subsist on the point that this is the work of a single architect (Monteiro 1995). Even if the walls of the church were already built when Castilho arrived, we note that the pillars were built later, in 1519.

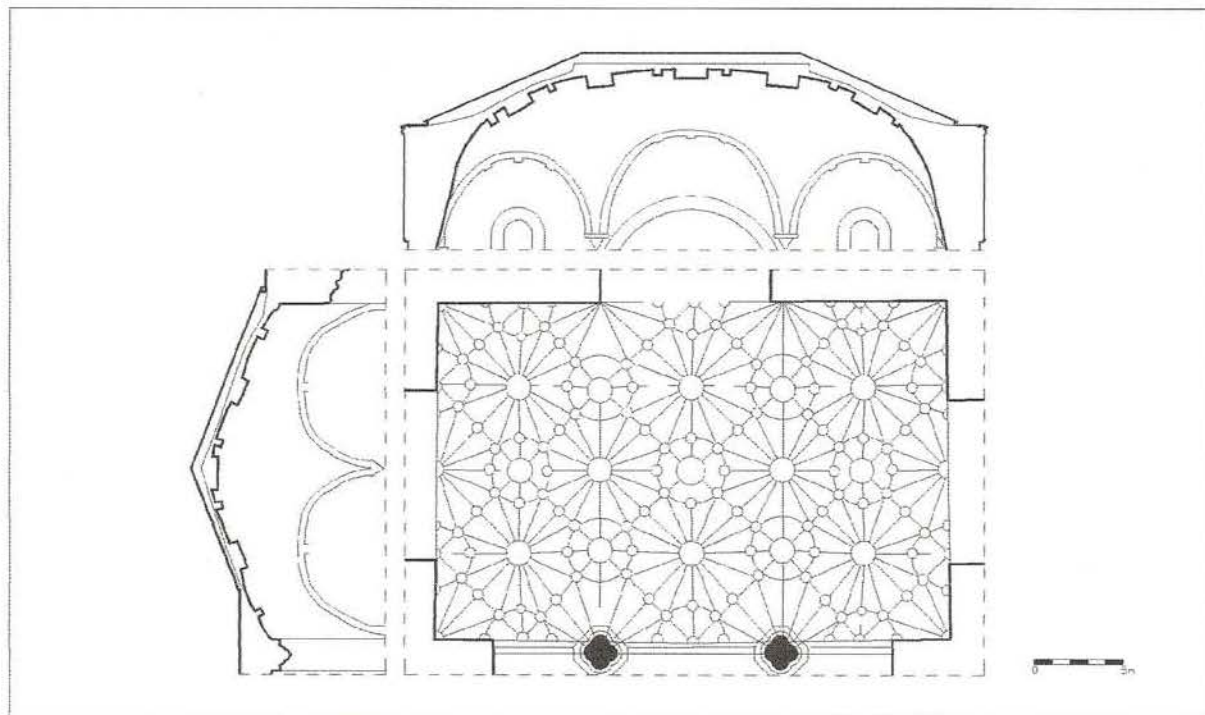


Figure 8: Transverse and longitudinal cross section and plan of the transept – Church of Jerónimos

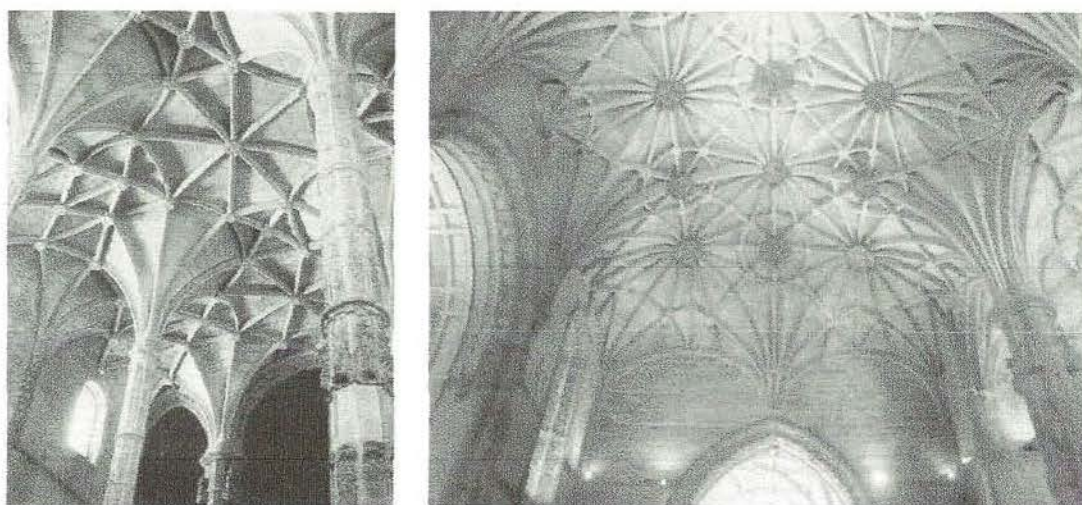


Figure 9: Nave and transept – Church of Jerónimos

CONCLUSIONS

This series of similar hall churches shows a highly original vaulting system which unifies nave and side aisles into one space as if, conceptually speaking, it were one single 'barrel' vault. Despite the Renaissance formal repertory, these rib vaults originated in the gothic. They respect the main geometric principle of the domed groin vault; i.e. their crown is defined by a semicircle through the diagonal.

Their shape gradually evolved so as to match the height of the side aisles with the central nave, and to connect the central and side parts by abolishing the traditional separating arches. In Setúbal and Viseu the side vaults are still low relative to the central one. From Freixo de Espada à Cinta onwards, the unified curvature becomes clearer as the vaults of the side aisles spring from the same level as the central ones, with little difference in the height of their crowns. Capitals and corbels are put on the same level, and from Arronches onwards the difference in profile between the various types of rib become insignificant (see Fig. 10), thus opening the way for a truly integrated single vault covering the whole main body. Subtle plays with rib patterns may serve to accentuate the main orthogonal grid (as in Moncorvo) or to obfuscate it (as in Jerónimos). There is no doubt that there is a coherent, formal evolution which links these cases logically. In any case, the geometrical design of these vaults follows a single principle from Freixo onwards, resulting in the characteristic flattish 'barrel' profile determined by the keystones of nave and aisles. Whether this is the result of a long period of conceptual development, or whether the signature of one individual architect (we are thinking of João de Castilho), remains to be ascertained.

	1	2	3	4	5	6	7
Transversal							
Longitudinal							
Diagonal							
Terceron							
Lieme							
Combado							

Figure 10: Profile of the ribs in the vaults of: the church of Jesus (1), the cathedral of Viseu (2), the church of Freixo de Espada à Cinta (3), the church of Arronches (4), the church of Torre de Moncorvo (5), the main body (6) and transept (7) of the church of Jerónimos

REFERENCES

Atanázio, M. C. M., 1984: *A arte do manuelino*. Lisbon: Presença.

Cavalheiro, E; Rebanda, N., 1998: *A igreja matriz de Torre de Moncorvo*. Mirandela: João Azevedo.

Chicó, M.T., 2005: *A Arquitectura gótica em Portugal*. Lisbon: Livros Horizonte.

Correia, V. 1922: *As obras de Santa Maria de Belém de 1514 a 1519*. Lisboa: Tipografia do Anuário Comercial.

Dias, P., 1978: *O Convento de Jesus de Setúbal na evolução da arquitectura manuelina*, Lisboa: Tip. Silvas

Genin, S., 2001: The Nave Vault of the Church of the Hieronymites Monastery in Lisbon. In: Lourenço, P.; Roca P. (eds): *Congress Historical Constructions – Possibilities of numerical and experimental techniques*, Guimarães, pp. 293-302.

Genin, S., 2003: Projecto de consolidação do tecto da igreja do mosteiro dos Jerónimos – Estudos preliminares. In: LNEC (ed.), *Congress 3ª Encore – Encontro sobre Conservação e Reabilitação de Edifícios*, Lisbon, pp. 653-671.

Monteiro, S. 1995: *Étude descriptive de la voûte de l'église du monastère de Santa Maria de Belém à Lisbonne*. Master's Thesis in Conservation, Leuven: Catholic University of Leuven.

Moreira, R., 1991: *A Arquitectura do Renascimento no Sul de Portugal. A Encomenda Régia entre o Moderno e o Romano*. Ph.D. Thesis, Lisbon: Universidade Nova de Lisboa.

Pintado, F. A., 1991: *Igreja Matriz de Freixo de Espada à Cinta*. Freixo de Espada à Cinta: Câmara Municipal

Silva, C. T.; Pereira, F. A. B., 1989: *Convento de Jesus, 500 anos, Arqueologia e História*: Câmara Municipal de Setúbal

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